

1 **Claims**

2

3 1. Apparatus for generating a mist comprising:
4 a conduit having a mixing chamber and an exit;
5 a working fluid inlet in fluid communication
6 with said conduit;
7 a transport nozzle in fluid communication with
8 the said conduit, the transport nozzle adapted to
9 introduce a transport fluid into the mixing chamber;
10 the transport nozzle having an angular orientation
11 and internal geometry such that in use the transport
12 fluid interacts with the working fluid introduced
13 into the mixing chamber through the working fluid
14 inlet to atomise and form a dispersed vapour/droplet
15 flow regime, which is discharged as a mist
16 comprising working fluid droplets, a substantial
17 portion of the droplets having a size less than
18 20 μ m.

19

20 2. The apparatus of claim 1, wherein the working
21 fluid droplets have a substantially uniform droplet
22 distribution having droplets with a size less than
23 20 μ m.

24

25 3. The apparatus of claim 1 or 2, wherein the
26 substantial portion of the droplets has a cumulative
27 distribution greater than 90%.

28

29 4. The apparatus of any preceding claim, wherein a
30 substantial portion of the droplets have a droplet
31 size less than 10 μ m

32

1 5. The apparatus of any preceding claim, wherein
2 the transport nozzle substantially circumscribes the
3 conduit.

4

5 6. The apparatus of any preceding claim, wherein
6 the mixing chamber includes a converging portion.

7

8 7. The apparatus of any of claims 1 to 5, wherein
9 the mixing chamber includes a diverging portion.

10

11 8. The apparatus of any preceding claim, wherein
12 the internal geometry of the transport nozzle has an
13 area ratio, namely exit area to throat area, in the
14 range 1.75 to 15, having an included α -angle
15 substantially equal to or less than 6 degrees for
16 supersonic flow, and substantially equal to or less
17 than 12 degrees for sub-sonic flow.

18

19 9. The apparatus of any preceding claim, wherein
20 the transport nozzle is oriented at an angle β of
21 between 0 to 30 degrees.

22

23 10. The apparatus of any preceding claim, wherein
24 the transport nozzle is shaped such that transport
25 fluid introduced into the mixing chamber through the
26 transport nozzle has a divergent or convergent flow
27 pattern.

28

29 11. The apparatus of claim 10, wherein the
30 transport nozzle has inner and outer surfaces each
31 being substantially frustoconical in shape.

32

1 12. The apparatus of any preceding claim, further
2 including a working nozzle in fluid communication
3 with the conduit for the introduction of working
4 fluid into the mixing chamber.

5

6 13. The apparatus of claim 12, wherein the working
7 nozzle is positioned nearer to the exit than the
8 transport nozzle.

9

10 14. The apparatus of claim 12 or 13 , wherein the
11 working nozzle is shaped such that working fluid
12 introduced into the mixing chamber through the
13 working nozzle has a convergent or divergent flow
14 pattern.

15

16 15. The apparatus of any of claims 12 to 14,
17 wherein the working nozzle has inner and outer
18 surfaces each being substantially frustoconical in
19 shape.

20

21 16. The apparatus of any preceding claim, further
22 including a second transport nozzle being adapted to
23 introduce further transport fluid or a second
24 transport fluid into the mixing chamber.

25

26 17. The apparatus of claim 16, wherein the second
27 transport nozzle is positioned nearer to the exit
28 than the transport nozzle.

29

30 18. The apparatus of claim 17, wherein the second
31 transport nozzle is positioned nearer to the exit
32 than the working nozzle, such that the working

1 nozzle is located intermediate the two transport
2 nozzles.

3

4 19. The apparatus of any preceding claim, wherein
5 the conduit includes a passage.

6

7 20. The apparatus of claim 19, wherein the inner
8 wall of the passage is adapted with a contoured
9 portion to induce turbulence of the working fluid
10 upstream of the transport nozzle.

11

12 21. The apparatus of any preceding claim, wherein
13 the mixing chamber includes an inlet for the
14 introduction of an inlet fluid.

15

16 22. The apparatus of any preceding claim, wherein
17 the mixing chamber is closed upstream of the
18 transport nozzle.

19

20 23. The apparatus of any preceding claim, further
21 including a supplementary nozzle arranged inside the
22 transport nozzle and adapted to introduce further
23 transport fluid or a second transport fluid into the
24 mixing chamber.

25

26 24. The apparatus of claim 23, wherein the
27 supplementary nozzle is arranged axially in the
28 mixing chamber.

29

30 25. The apparatus of claim 23 or 24, wherein the
31 supplementary nozzle extends forward of the
32 transport nozzle.

1

2 26. The apparatus of any of claims 23 to 25,
3 wherein the supplementary nozzle is shaped with a
4 convergent-divergent profile to provide supersonic
5 flow of the transport fluid which flows
6 therethrough.

7

8 27. The apparatus of any preceding claim, further
9 including control means adapted to control one or
10 more of droplet size, droplet distribution, spray
11 cone angle and projection distance.

12

13 28. The apparatus of any preceding claim, further
14 including control means to control one or more of
15 the flow rate, pressure, velocity, quality, and
16 temperature of the inlet and/or working and/or
17 transport fluids.

18

19 29. The apparatus of claim 27 or 28, wherein the
20 control means includes means to control the angular
21 orientation and internal geometry of the working
22 and/or transport and/or secondary nozzles.

23

24 30. The apparatus of any of claims 27 to 29,
25 wherein the control means includes means to control
26 the internal geometry of at least part of the mixing
27 chamber or exit to vary it between convergent and
28 divergent.

29

30 31. The apparatus of any preceding claim, wherein
31 the exit of the apparatus is provided with a cowl to
32 control the mist.

1

2 32. The apparatus of claim 31, wherein the cowl
3 comprises a plurality of separate sections arranged
4 radially, each section adapted to control and re-
5 direct a portion of the discharge of mist emerging
6 from the exit.

7

8 33. The apparatus of any preceding claim, wherein
9 the apparatus for generating a mist is located
10 within a further cowl.

11

12 34. The apparatus of any preceding claim, wherein
13 at least one of the transport, secondary or working
14 nozzles is adapted with a turbulator to enhance
15 turbulence.

16

17 35. A spray system comprising apparatus of any of
18 claims 1 to 34 and transport fluid in the form of
19 steam.

20

21 36. The spray system of claim 35, further including
22 working fluid in the form of water.

23

24 37. The spray system of claim 35 or 36, further
25 including a steam generator and water supply.

26

27 38. The spray system of claim 37, wherein the spray
28 system is portable.

29

30 39. A method of generating a mist comprising the
31 steps of:

- 1 providing apparatus for generating a mist
 - 2 comprising a transport nozzle and a conduit, the
 - 3 conduit having a mixing chamber and an exit;
 - 4 introducing a stream of transport fluid into
 - 5 the mixing chamber through the transport nozzle;
 - 6 introducing a working fluid into the mixing
 - 7 chamber;
 - 8 atomising the working fluid by interaction of
 - 9 the transport fluid with the working fluid to form a
 - 10 dispersed vapour/droplet flow regime; and
 - 11 discharging the dispersed vapour/droplet flow
 - 12 regime through the exit as a mist comprising working
 - 13 fluid droplets, a substantial portion of the
 - 14 droplets having a size less than 20 μm .
- 15
- 16 40. The method of claim 39, wherein the apparatus
 - 17 is an apparatus according to any of claims 1 to 38.
- 18
- 19 41. The method of claim 39 or 40, wherein the
 - 20 stream of transport fluid introduced into the mixing
 - 21 chamber is annular.
- 22
- 23 42. The method of any of claims 39 to 41, wherein
 - 24 the working fluid is introduced into the mixing
 - 25 chamber via an inlet of the mixing chamber of the
 - 26 apparatus.
- 27
- 28 43. The method of any of claims 39 to 41, wherein
 - 29 the working fluid is introduced into the mixing
 - 30 chamber via a working nozzle in fluid communication
 - 31 with the conduit of the apparatus.
- 32

1 44. The method of claim 43, wherein an inlet fluid
2 is introduced into the mixing chamber via an inlet
3 of the mixing chamber of the apparatus.

4

5 45. The method of any of claims 39 to 44, wherein
6 the method includes the step of introducing the
7 transport fluid into the mixing chamber in a
8 continuous or discontinuous or intermittent or
9 pulsed manner.

10

11 46. The method of any of claims 39 to 45, wherein
12 the method includes the step of introducing the
13 transport fluid into the mixing chamber as a
14 supersonic flow.

15

16 47.. The method of any of claims 39 to 46, wherein
17 the method includes the step of introducing the
18 transport fluid into the mixing chamber as a sub-
19 sonic flow.

20

21 48. The method of any of claims 39 to 47, wherein
22 the method includes the step of introducing the
23 working fluid into the mixing chamber in a
24 continuous or discontinuous or intermittent or
25 pulsed manner.

26

27 49. The method of any of claims 39 to 48, wherein
28 the mist is controlled by modulating at least one of
29 the following parameters:

30 the flow rate, pressure, velocity, quality
31 and/or temperature of the transport fluid;

1 the flow rate, pressure, velocity, quality
2 and/or temperature of the working fluid;
3 the flow rate, pressure, velocity, quality
4 and/or temperature of the inlet fluid;
5 the angular orientation of the transport and/or
6 working and/or secondary nozzle(s) of the apparatus;
7 the internal geometry of the transport and/or
8 working and/or secondary nozzle(s) of the apparatus;
9 and
10 the internal geometry, length and/or cross
11 section of the mixing chamber.

12
13 50. The method of claim 49, wherein the mist is
14 controlled to have a substantial proportion of its
15 droplets having a size less than 20 μm .

16
17 51. The method of claim 49, wherein the mist is
18 controlled to have a substantial proportion of its
19 droplets having a size less than 10 μm .

20
21 52. The method of any of claims 39 to 51, including
22 the generation of condensation shocks and/or
23 momentum transfer to provide suction within the
24 apparatus.

25
26 53. The method of any of claims 39 to 52, including
27 inducing turbulence of the inlet fluid prior to it
28 being introduced into the mixing chamber.

29
30 54. The method of any of claims 39 to 53, including
31 inducing turbulence of the working fluid prior to it
32 being introduced into the mixing chamber.

1

2 55. The method of any of claims 39 to 54, including
3 inducing turbulence of the transport fluid prior to
4 it being introduced into the mixing chamber.

5

6 56. The method of any of claims 39 to 55, wherein
7 the transport fluid is steam or an air/steam
8 mixture.

9

10 57. The method of any of claims 39 to 56, wherein
11 the working fluid is water or a water-based liquid.

12

13 58. The method of any of claims 39 to 57, wherein
14 the mist is used for fire suppression.

15

16 59. The method of any of claims 39 to 58, wherein
17 the mist is used for decontamination.

18

19 60. The method of any of claims 36 to 59, wherein
20 the mist is used for gas scrubbing.